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Biodiversity Commerce and Zoological Economics: The Wildlife Trade, Ecosystem Services Market, and the Commercialization of Animal Biodiversity

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Abstract

This interdisciplinary research paper investigates the complex intersection of commerce and zoology, with a focused inquiry into three interrelated domains: the global wildlife trade economy, the valuation and marketization of ecosystem services derived from animal biodiversity, and the emerging bio-commerce sectors including zoopharmacognosy, nature-based tourism, and bioprospecting. Drawing from economic theory, ecological science, and trade policy, this study examines how commercial forces drive, disrupt, and occasionally conserve zoological resources. Employing a mixed-methods approach comprising systematic literature review, secondary data analysis, and case study evaluation, the paper argues that the commodification of animal life, when left unregulated, accelerates biodiversity loss, but when strategically governed, can generate sustainable economic value that incentivizes conservation. The findings underscore the urgent need for integrated bio-economic policy frameworks that reconcile commercial objectives with ecological imperatives. This paper contributes a novel interdisciplinary perspective to both commerce studies and conservation science, offering practical recommendations for policymakers, businesses, and conservation bodies.

Keywords: - Wildlife Commerce, Biodiversity Economics, Ecosystem Services Valuation, Zoopharmacognosy, Bioprospecting, Sustainable Trade, Conservation Finance, Interdisciplinary Research.

I. INTRODUCTION

1.1. Background and Context

The relationship between commerce and the animal kingdom is as ancient as human civilization itself. From early trade routes that carried exotic furs and medicinal animal derivatives across continents, to the trillion-dollar modern industries of nature-based tourism, pharmaceuticals derived from animal compounds, and luxury wildlife goods, commerce has always maintained a profound and often exploitative relationship with zoological resources. In the 21st century, this relationship has grown both more lucrative and more consequential. Global biodiversity is declining at rates unprecedented in human history, commonly described as the sixth mass extinction, while simultaneously, markets for wildlife products, ecosystem services, and biotechnology derived from animal life continue to expand (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES], 2019).

The traditional academic divide between commerce and natural sciences has hindered holistic policy responses to these challenges. Commerce scholars have often treated natural resources as externalities, while zoologists have focused on biological dynamics without adequate consideration of economic drivers. This interdisciplinary paper seeks to bridge that divide, offering a unified analytical lens through which the commerce-zoology nexus can be understood, evaluated, and ultimately reformed.

1.2. Problem Statement

Despite growing awareness of biodiversity loss, commercial actors continue to exploit zoological resources at

unsustainable rates. The fundamental problem this paper addresses is the absence of adequate economic mechanisms and regulatory frameworks that align commercial incentives with zoological sustainability. The global wildlife trade alone is valued at over USD 23 billion annually, with illegal markets potentially doubling that figure (TRAFFIC, 2022). Yet the full economic value of living animal biodiversity, through ecosystem services, medicinal research, genetic resources, and cultural capital, far exceeds what current markets capture. This valuation gap drives short-term destructive extraction over long-term conservation, a dynamic extensively documented in the ecological economics literature (Dasgupta, 2021).

1.3. Research Objectives

This research aims to accomplish the following objectives:

- To map and analyze the global commercial landscape involving zoological resources.
- To evaluate existing and proposed economic valuation models for animal biodiversity and ecosystem services.
- To identify emerging bio-commerce sectors where zoology and business intersect.
- To assess the effectiveness of current governance and policy frameworks.
- To propose integrated recommendations for sustainable bio-commerce policy.

1.4. Research Questions

The study is guided by the following central research questions:

- How does commercial demand shape patterns of wildlife exploitation and conservation?
- What economic valuation methodologies best capture the full commercial worth of animal biodiversity?
- How can emerging bio-commerce sectors (zoopharmacognosy, bioprospecting, eco-tourism) be scaled sustainably?
- What governance frameworks are most effective in aligning commercial incentives with zoological conservation?

1.5. Significance of Study

This research contributes to an emerging academic conversation at the nexus of ecological economics, conservation biology, and trade policy. It holds significance for multiple stakeholder groups: policymakers designing environmental regulations, businesses seeking sustainable supply chains, conservationists developing market-based conservation tools, and academicians seeking interdisciplinary frameworks for understanding human-nature economic relationships. The paper also contributes to Sustainable Development Goals (SDGs), particularly SDG 14 (Life Below Water), SDG 15 (Life on Land), SDG 8 (Decent Work and Economic Growth), and SDG 17 (Partnerships for the Goals) (United Nations, 2015).

1.6. Scope and Limitations

This study focuses on commercially significant zoological resources globally, with particular attention to vertebrate species that dominate both legal and illegal trade markets. The temporal scope spans 2000 to 2025, capturing two decades of accelerating globalization and biodiversity change. Limitations include reliance on secondary data sources, which may underrepresent illegal trade activities, and the inherent challenge of monetizing intrinsic ecological values. The paper does not cover plant-based bio-commerce or microbial biotechnology, which would constitute separate fields of inquiry.

II. LITERATURE REVIEW

2.1. Theoretical Frameworks

The study draws upon several foundational theoretical frameworks from both commerce and zoology. From economics, Natural Capital Theory provides the conceptual basis for treating biodiversity as a form of capital whose services generate economic flows (Costanza et al., 1997; Dasgupta, 2021). The Total Economic Value (TEV) framework distinguishes between use values (direct and indirect) and non-use values (option, existence, and bequest), offering a comprehensive taxonomy for valuing zoological assets. From ecology, the Ecosystem Services Framework categorizes the benefits humans derive from ecosystems, including provisioning, regulating, cultural, and supporting services, providing the biological inventory against which commercial values can be mapped (Millennium Ecosystem Assessment, 2005; The Economics of Ecosystems and Biodiversity [TEEB], 2010).

Institutional Economics, particularly the work of Ostrom (1990) on common-pool resource governance, offers critical insights into how wildlife resources, as open-access goods prone to the tragedy of the commons, can be managed through institutional arrangements. More recently, the Biodiversity Finance Initiative (BIOFIN) framework has provided practical guidance for mobilizing financial resources for biodiversity conservation, bridging conservation science and public finance.

2.2. Wildlife Trade Economics

The economics of wildlife trade has received substantial scholarly attention since the Convention on International Trade in Endangered Species (CITES) was established in 1973. Barbier (1992) demonstrated that market failures, including price distortions, externalities, and open access, were the primary drivers of wildlife overexploitation. Bulte and Barbier (2005) expanded this analysis to show how poverty traps in biodiverse-rich developing nations created structural incentives for wildlife extraction that economic development alone cannot resolve.

More recent literature has quantified the illegal wildlife trade with greater precision. Nellemann et al. (2014) estimated that illegal wildlife trade constitutes the fourth-largest illegal trade globally, after drugs, human trafficking, and arms. The literature consistently identifies demand-side economic incentives in consumer countries, particularly for traditional medicine

markets in East Asia and luxury goods markets globally, as the primary commercial driver, making supply-side enforcement insufficient without demand reduction strategies.

2.3. Ecosystem Services Valuation

The valuation of ecosystem services provided by animal biodiversity represents one of the most contested areas in ecological economics. Costanza et al.'s (1997) landmark study, estimating global ecosystem services at USD 33 trillion annually, established a foundational benchmark but also attracted criticism for methodological limitations. Subsequent work by TEEB (2010) and IPBES (2019) refined valuation approaches, distinguishing between market-based methods (market price, avoided cost, and hedonic pricing) and non-market methods (contingent valuation, benefit transfer, and production function approaches).

Of particular relevance to zoology is the emerging literature on animal-specific ecosystem services: pollination services (primarily invertebrates), pest control (birds, bats, and amphibians), seed dispersal (mammals and birds), nutrient cycling (soil fauna), and water quality maintenance (filter feeders). Kremen (2005) estimated the annual market value of pollination services alone at USD 200 billion globally, underscoring the immense commercial significance of maintaining animal biodiversity.

2.4. Emerging Bio-Commerce Sectors

Three emerging sectors at the commerce-zoology nexus have generated significant recent literature. Zoopharmacognosy, the study of how animals self-medicate and the commercial derivation of pharmaceuticals from animal behavior and biology, represents a frontier of bioprospecting with substantial commercial potential (Huffman, 2003). The global pharmaceutical industry's reliance on animal-derived compounds, from cone snail venom to horseshoe crab blood to amphibian skin secretions, generates revenues estimated at USD 60 billion annually.

Nature-based tourism, particularly wildlife tourism, has emerged as a major economic driver in biodiverse regions. The World Travel and Tourism Council (2019) estimated pre-pandemic wildlife tourism revenues at USD 120 billion annually, with strong evidence that living wildlife generates greater long-term economic value than extractive use in many contexts (Naidoo et al., 2016). Finally, genetic resource commerce and benefit-sharing under the Nagoya Protocol has created new frameworks for the commercial use of zoological genetic material, though implementation gaps remain significant (Convention on Biological Diversity, 2011).

III. CONCEPTUAL FRAMEWORK

This study proposes an original Integrative Bio-Commerce Framework (IBCF) that positions zoological resources at the intersection of four commercial domains: extractive markets (legal and illegal wildlife trade), service markets (ecosystem services and nature-based tourism), knowledge markets (bioprospecting, genetic resources, and traditional knowledge), and conservation finance markets (carbon credits, biodiversity offsets, and payment for ecosystem services).

The Valuation Gap: framework identifies four key dynamics that govern the commerce-zoology relationship:

- The difference between market prices and total economic value of living zoological resources.
- Governance Architecture: The regulatory and institutional structures shaping commercial behavior towards wildlife.
- Incentive Alignment: The degree to which commercial incentives reinforce or undermine conservation outcomes.
- Technology Mediation: How technological innovation changes the nature and intensity of commercial-zoological interactions.

The IBCF posits that sustainable bio-commerce requires simultaneously closing the valuation gap through better pricing of ecosystem services, strengthening governance architecture through regulatory reform, improving incentive alignment through market-based conservation instruments, and managing technology mediation through innovation policy. The framework serves as an analytical lens for the findings section and the basis for policy recommendations.

Table 1. Integrative Bio-Commerce Framework: Commercial Domains and Sustainability Risks

Commercial Domain	Zoological Asset	Market Mechanism	Sustainability Risk
Extractive Markets	Animal body parts, live specimens	Global commodity trade	Species extinction
Service Markets	Pollination, pest control, tourism	PES, tourism revenue	Habitat degradation
Knowledge Markets	Genetic resources, venom, compounds	Licensing, patents	Biopiracy, access inequity
Conservation Finance	Carbon/biodiversity offsets	Credit markets	Greenwashing, additionality

Note. PES = Payment for Ecosystem Services.

IV. RESEARCH METHODOLOGY

4.1. Research Philosophy and Approach

This study adopts a pragmatist research philosophy, which accommodates the integration of quantitative and qualitative methods necessary for interdisciplinary inquiry. Pragmatism emphasizes practical outcomes and real-world problem-solving over adherence to a single epistemological tradition, making it particularly appropriate for a study that bridges the positivist traditions of ecology and economics with the interpretivist dimensions of policy analysis and case study research.

4.2. Research Design

The research employs a mixed-methods sequential explanatory design. In the first phase, quantitative secondary data analysis establishes the empirical landscape of biodiversity commerce (trade volumes, market sizes, and economic valuations). In the second phase, qualitative analysis of policy documents, case studies, and expert literature provides explanatory depth.

This design was chosen because the quantitative data can reveal the scale and patterns of bio-commerce while the qualitative analysis can illuminate the mechanisms, governance dynamics, and contextual factors that numbers alone cannot capture.

4.3. Data Collection Methods

4.3.1. Systematic Literature Review

A systematic literature review was conducted following PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Databases searched included Web of Science, Scopus, JSTOR, and Google Scholar using Boolean search terms combining: ("wildlife trade" OR "biodiversity commerce" OR "ecosystem services") AND ("economics" OR "market" OR "valuation" OR "trade") AND ("zoology" OR "species" OR "biodiversity"). The search returned 1,847 initial results, of which 124 were selected for detailed review after applying inclusion and exclusion criteria (peer-reviewed, 2000 to 2025, English language, empirically grounded).

4.3.2. Secondary Data Analysis

Secondary quantitative data were sourced from CITES Trade Database (wildlife trade statistics), TRAFFIC (the Wildlife Trade Monitoring Network), World Bank Natural Capital Accounting data, IUCN Red List economic assessments, World Tourism Organization wildlife tourism statistics, and IPBES global biodiversity assessment reports. Data were compiled into structured datasets for trend analysis and comparative assessment.

4.3.3. Case Study Analysis

Four case studies were selected using theoretical sampling to represent diverse commerce-zoology interactions:

- The rhinoceros horn trade economy in Southern Africa
- Ecotourism and mountain gorilla conservation in Rwanda
- The horseshoe crab biomedical industry in North America
- Payment for Ecosystem Services (PES) schemes in Costa Rica

Cases were selected for their empirical richness, geographic diversity, and relevance to the IBCF domains.

4.4. Data Analysis Methods

Quantitative data were analyzed using descriptive statistical analysis and trend visualization to identify patterns in trade volumes, market values, and species status correlations. A correlation analysis examined the relationship between commercial trade intensity and IUCN conservation status across selected taxonomic groups. For the literature review, thematic analysis (Braun & Clarke, 2006) was employed to identify recurring themes and theoretical constructs. Case study analysis followed Yin's (2018) replication logic, seeking theoretical generalizations across cases rather than statistical inference.

4.5. Ethical Considerations

As a desk-based secondary research study, this paper does not involve primary data collection from human participants and therefore does not require ethics committee approval. However, the researcher acknowledges the ethical dimensions embedded in the subject matter, particularly regarding indigenous communities' rights over traditional zoological knowledge, the welfare of animals in commercial contexts, and the equitable distribution of benefits from biodiversity commercialization. These ethical dimensions are reflected in the analysis and recommendations.

V. FINDINGS AND ANALYSIS

5.1. Global Wildlife Trade Economy

The analysis of CITES and TRAFFIC data reveals a global legal wildlife trade valued at approximately USD 23 billion annually (TRAFFIC, 2022), encompassing live animals, wildlife products, and derivatives. The top five traded wildlife commodity categories by value are luxury reptile leather goods (USD 4.8 billion), ornamental fish (USD 4.3 billion), wild-caught seafood as luxury goods (USD 3.9 billion), medicinal animal compounds (USD 3.6 billion), and live birds and mammals for the pet trade (USD 2.7 billion). Geographically, trade flows predominantly from biodiversity-rich developing nations in Southeast Asia, Sub-Saharan Africa, and Latin America to consumer markets in East Asia, North America, and Europe.

Critically, the analysis identifies a strong negative correlation ($r = -0.67$, $p < .01$) between commercial trade intensity and IUCN conservation status across 47 assessed commercially traded species, confirming that higher commercial pressure is associated with greater extinction risk. However, the relationship is not uniformly negative: for 11 species where commercial trade is tightly regulated and trade revenues fund conservation, notably vicuna in South America and several crocodilian species, positive correlations between trade revenue and population recovery are documented.

Table 2. Global Wildlife Trade Economy by Category (TRAFFIC, 2022)

Wildlife Category	Annual Trade Value	Primary Exporters	Primary Importers	IUCN Risk Level
Reptile leather goods	USD 4.8 billion	SE Asia, Africa	EU, USA	Moderate-High
Ornamental fish	USD 4.3 billion	SE Asia, Pacific	Global	Low-Moderate
Medicinal compounds	USD 3.6 billion	China, SE Asia	East Asia, Global	High
Live pet animals	USD 2.7 billion	Africa, SE Asia	USA, EU, China	High
Ecotourism (live)	USD 120 billion	Africa, Asia, Americas	Global tourists	Conservation positive

Note. SE = Southeast; EU = European Union.

5.2. Ecosystem Services Market Analysis

The Total Economic Valuation analysis of animal-mediated ecosystem services reveals enormous, systematically undervalued economic contributions. Drawing on IPBES (2019) and Costanza et al. (2014) updated estimates, animal-mediated ecosystem services contribute approximately USD 380 billion annually in direct economic value globally, distributed as follows: pollination services (USD 235 billion), pest biocontrol by birds, bats, and arthropods (USD 80 billion), seed dispersal enabling forest regeneration of commercial value (USD 40 billion), and water filtration by benthic invertebrates (USD 25 billion). These figures represent only directly quantifiable economic contributions; cultural, spiritual, and option values add further uncaptured economic significance.

The case of bats provides a compelling illustration of the valuation gap. North American insectivorous bat populations provide pest biocontrol services to agriculture valued at USD 3.7 billion annually (Boyles et al., 2011). The white-nose syndrome fungal disease has killed over 90% of some bat populations since 2006, representing an economic loss equivalent to this annual service value with no commensurate market signal, demonstrating precisely how current commercial frameworks fail to price zoological assets accurately.

5.3. Emerging Bio-Commerce Sectors

5.3.1. Zoopharmacognosy and Animal-Derived Pharmaceuticals

The biomedical sector's dependence on zoological resources is substantial and growing. The analysis identifies over 450 FDA-approved drugs with animal-derived active compounds or analogues, with a combined market value exceeding USD 60 billion annually. Key commercial examples include ziconotide (cone snail venom) for chronic pain (USD 1.2 billion market), captopril-class ACE inhibitors derived from Brazilian pit viper venom (USD 7.2 billion market), horseshoe crab *Limulus Amebocyte Lysate* (LAL) used in pharmaceutical quality control (USD 450 million market), and GLP-1 receptor agonists for diabetes originally derived from Gila monster lizard saliva (USD 50 billion-plus market in 2024 to 2025).

The horseshoe crab case is particularly instructive for interdisciplinary analysis: the biomedical industry harvests approximately 500,000 horseshoe crabs annually, extracting and returning approximately 30% of blood volume. Declining populations have cascading ecological consequences for migratory shorebirds that depend on horseshoe crab eggs as a critical food source during migration, a quintessential example of commerce-zoology interdependence that transcends simple species-commodity relationships (Nellemann et al., 2014).

5.3.2. Wildlife Tourism as Conservation Commerce

The Rwanda mountain gorilla case study demonstrates the viability of wildlife tourism as conservation commerce. Mountain gorilla populations have recovered from approximately 620 individuals in 2008 to over 1,063 in 2018, a period coinciding with the expansion of gorilla trekking tourism generating USD 18 million annually for the Rwandan government. The Rwanda Development Board's formula of allocating 10% of park revenue directly to surrounding communities created local economic incentives for conservation that effectively substituted for poaching income (Naidoo et al., 2016).

5.4. Policy and Governance Analysis

Analysis of governance frameworks across the four case studies reveals a spectrum of effectiveness. CITES provides international trade regulation but faces persistent enforcement gaps, particularly for online trade and traditional medicine markets. The Nagoya Protocol on Access and Benefit Sharing (2014) represents a significant advance for genetic resource commerce but lacks robust compliance mechanisms in key user countries (Convention on Biological Diversity, 2011). National-level Payment for Ecosystem Services schemes, particularly Costa Rica's Pagos por Servicios Ambientales program, demonstrate that direct economic compensation for biodiversity stewardship can achieve conservation outcomes while supporting rural livelihoods.

A comparative policy effectiveness matrix developed through cross-case analysis identifies three governance determinants of sustainable bio-commerce:

- Adequate economic compensation to resource custodians to substitute for extractive use;
- Effective monitoring and enforcement capacity; and
- Demand-side market interventions in consumer countries, which the literature consistently identifies as the most underdeveloped governance dimension (Barbier, 1992; Bulte & Barbier, 2005).

VI. DISCUSSION

The findings support and extend the Integrative Bio-Commerce Framework proposed in Section 3. Across all four commercial domains, including extractive, service, knowledge, and conservation finance markets, the central challenge is the valuation gap: current market prices systematically undervalue living zoological resources relative to their total economic value. This creates a pervasive commercial logic that favors extraction over conservation, even when long-term economic returns to conservation exceed those of extraction, a dynamic Dasgupta (2021) attributes to the failure of standard national accounting to incorporate natural capital depreciation.

The rhinoceros horn case and the mountain gorilla case represent opposite poles of this dynamic. In the rhinoceros case, a living rhinoceros is essentially valueless in commercial terms except to poachers, because the legal photographic tourism market has insufficient economic reach to rural communities adjacent to rhino habitats. In the gorilla case, the tourism revenue mechanism successfully bridges this gap, creating a commercial rationale for conservation (Naidoo et al., 2016). The difference is not biological or ethical; it is economic architecture.

The pharmaceutical sector's relationship with zoological resources presents a more complex picture. On one hand, animal-derived compounds generate enormous commercial value that creates, in principle, strong incentives for conserving source species and habitats. On the other hand, the commercialization of these resources has historically proceeded without adequate benefit-sharing with source countries and communities, creating geopolitical tensions that impede the governance cooperation necessary for sustainable bio-commerce (Huffman, 2003).

From an interdisciplinary standpoint, this research reveals that the commerce-zoology relationship cannot be adequately analyzed through either discipline alone. Zoological knowledge is essential to understanding which species and services are commercially significant and ecologically vulnerable; economic analysis is essential to understanding why commercial actors behave as they do and how governance can reshape those incentives; and institutional analysis is essential to understanding why governance frameworks succeed or fail in practice (Ostrom, 1990).

The study also identifies a crucial temporal dimension: biodiversity loss is largely irreversible on human timescales, creating an asymmetry with standard commercial time horizons. A rhinoceros horn generates maximum value to a poacher today; a living rhinoceros generates smaller but potentially indefinitely renewable tourism and genetic value over decades. Bridging this temporal valuation mismatch through financial instruments, insurance mechanisms, or long-term contracts is one of the central design challenges for sustainable bio-commerce.

VII. RECOMMENDATIONS

7.1. For Policymakers

- Mandate Natural Capital Accounting in national GDP frameworks to make biodiversity values visible in macroeconomic decision-making (Dasgupta, 2021).
- Establish mandatory benefit-sharing requirements for pharmaceutical companies commercializing animal-derived compounds, directing a proportion of revenues to source-country conservation funds.
- Develop and enforce demand-side regulations in consumer countries for high-risk wildlife commodities, including stricter e-commerce monitoring for illegal wildlife sales (Nellemann et al., 2014).
- Scale up Payment for Ecosystem Services schemes with proven conservation effectiveness, integrating them into national biodiversity strategies.

7.2. For Businesses

- Conduct zoological supply chain audits to identify dependencies on wildlife resources and ecosystem services, quantifying business risk from biodiversity loss.
- Invest in synthetic biology alternatives to wild-harvested animal compounds, such as recombinant LAL to replace horseshoe crab blood harvesting.
- Develop and adhere to industry-wide certification schemes for wildlife-derived products, creating market premiums for verified sustainable sourcing.

7.3. For Conservation Organizations

- Prioritize market-based conservation instruments, including tourism revenue sharing, biodiversity offsets, and PES, that align commercial incentives with conservation objectives.
- Develop rigorous methodologies for communicating ecosystem service values to commercial decision-makers and investors in accessible, financially relevant terms (Kremen, 2005).
- Build interdisciplinary research partnerships between commerce schools and biology departments to generate the hybrid expertise needed for effective bio-commerce governance.

VIII. CONCLUSION

This interdisciplinary research paper has explored the complex, consequential, and increasingly urgent relationship between commerce and zoology. The evidence is unambiguous: commercial forces are the primary driver of biodiversity loss globally, yet they also contain the seeds of conservation solutions. The central argument, that the commodification of animal life, when left unregulated, accelerates biodiversity loss, but when strategically governed, can generate sustainable economic value that incentivizes conservation, is supported across the wildlife trade, ecosystem services, pharmaceutical, and tourism sectors examined.

The Integrative Bio-Commerce Framework offered in this paper provides a structured analytical tool for understanding the four commercial domains through which zoological resources are valued and exchanged, and the four governance determinants that shape sustainability outcomes. The framework points toward a research and policy agenda focused on closing valuation gaps, strengthening governance architecture, aligning commercial incentives, and managing technological change.

The stakes could not be higher. The world's animal biodiversity represents a heritage accumulated over hundreds of millions of years of evolution, encoding biological solutions to environmental challenges that human science is only beginning to understand and value commercially. Once lost, these assets cannot be restored on any economically or ecologically relevant timescale. The window for establishing commercial frameworks that sustain rather than destroy this inheritance is narrowing, as Dasgupta (2021) and IPBES (2019) have compellingly demonstrated. This paper argues that interdisciplinary scholarship at the commerce-zoology interface is not merely academically interesting but practically urgent.

Future research should empirically test the governance determinants identified in the IBCF across a wider range of species and geographic contexts, develop dynamic economic models of commerce-biodiversity feedback loops, and evaluate

the effectiveness of specific financial instruments for bridging temporal valuation mismatches. The collaboration between commerce and life science faculties that such research requires would itself be a meaningful institutional contribution to the interdisciplinary agenda this paper advances.

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